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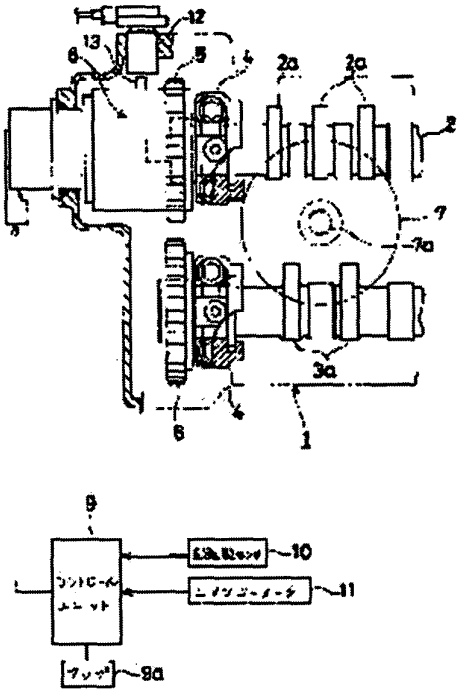
(54) FOUR-CYCLE ENGINE

(57)Abstract:

PURPOSE: To increase output to a high level and decrease fuel consumption by setting a compression ratio to a high level and suppressing generation of knocking.

CONSTITUTION: A compression ratio is set to a high value for good heat efficiency and a variable mechanism 8 for varying opening/closing timing of an intake valve is provided on an intake cam shaft 2. A control unit 9 for varying the valve closing timing of the intake valve at the time of low-rotation high-load is connected to the variable mechanism 9. The valve closing timing of the intake valve is varied at the time of low-rotation high-load, and startup timing of compression is delayed and then real compression ratio is decreased. Consequently, the compression ratio can be set to a high level while knocking is suppressed, and high output can be secured and fuel consumption is decreased.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the equipment which stops that lower a compression ratio at the time of a low rotation heavy load, and knocking occurs especially about the four stroke cycle engine opened and closed by the valve gear with an inlet valve separate [an exhaust valve].
[0002]
[Description of the Prior Art] It is desirable to raise a compression ratio as much as possible for aiming at improvement in an output and improvement in mpg by the four stroke cycle engine. However, when it does in this way, a limit is shown also in attaining high compression ratio-ization from the relation knocking becomes easy to produce. Although it is hard to be generated even if it enlarges a compression ratio from a relation with an effective pressure there are few air contents inhaled in a cylinder, and small, when an engine load is small, since the charging efficiency of inhalation of air becomes high at the time of a heavy load, if a compression ratio is set up greatly, it will become easy to produce this knocking.
[0003] From the time of high rotation a gaseous mixture is stirred by whose strong turbulent flow also in the time of this heavy load, the direction at the time of the low rotation whose gas flow decreases comparatively within a cylinder tends to produce knocking.
[0004] The conventional four stroke cycle engine was set as the compression ratio which is the grade which knocking does not generate at the time of a low rotation heavy load. And when knocking occurred, the knock sensor detected it, and ignition timing was delayed so that it might be hard to produce knocking and it might become.
[0005]
[Problem(s) to be Solved by the Invention] However, there was a limit also in raising the output and mpg of an engine in having set the compression ratio as the small value which is the grade which knocking does not generate at the time of a low rotation heavy load, as mentioned above. And if ignition timing is delayed when knocking arises, torque will fall.
[0006] It stops that knocking produces it, setting [this invention was made in order to cancel such a trouble, and] up a compression ratio highly, and aims at attaining a high increase in power and low mpg-ization.
[0007]
[Means for Solving the Problem] The four stroke cycle engine concerning this invention establishes the adjustable mechanism in which the opening-and-closing time of an inlet valve is changed into a valve gear, and connects to this adjustable mechanism the control unit which changes the valve-closing time of an inlet valve according to the grade of knocking while it sets a compression ratio as a high value with sufficient thermal efficiency.
[0008]
[Function] A substantial compression ratio becomes [that the stage when the angle of delay of the valve-closing stage of an inlet valve is sharply carried out at at the time of the service condition (low rotation heavy load) to which knocking tends to take place, and a compression stroke starts is overdue and a charging efficiency] low small by the bird clapper. For this reason, at the time of a low rotation heavy load, combustion is performed with the real compression ratio as abbreviation conventional, knocking is suppressed and combustion is performed with the highest real compression ratio by controlling the valve-closing stage of an inlet valve according to the grade of the knocking at the time of other service conditions.
[0009]
[Example] Hereafter, drawing 1 or drawing 3 explains one example of this invention in detail. The plan which drawing 1 expands the important section of the four stroke cycle engine concerning this invention, and is shown, and drawing 2 are drawings showing the opening-and-closing timing of an inlet valve and an exhaust valve, this drawing (a) shows

the state when not operating an adjustable mechanism, this drawing (b) shows the state when carrying out 20-degree angle of delay of the valve-closing stage of an inlet valve, and this drawing (c) shows the state when carrying out 40-degree angle of delay of the valve-closing stage of an inlet valve. Drawing 3 is the map of the amount of inhalation-of-air valve timing angles of delay.

[0010] In these drawings, 1 is a four stroke cycle engine concerning this invention, and this engine 1 is the so-called 2 overhead-location cam shaft formula engine which opens and closes an inlet valve (not shown) and an exhaust valve (not shown) by the separate cam shaft. Moreover, the compression ratio of this engine 1 is set as the comparatively high value to the conventional engine. If it explains in full detail, it is set as the high value knocking becomes easy to generate at the time of a low rotation heavy load. Specifically, it is 11.5 or more.

[0011] It is the air inlet cam shaft with which 2 opens and closes an inlet valve, and the exhaust air cam shaft to which 3 opens and closes an exhaust valve, and these cam shafts are supported by cylinder head 1a respectively free [rotation] by bearing 4, and the pulley gear teeth 5 and 6 formed in the axis end section are connected with the crankshaft (not shown) through the non-illustrated timing belt.

[0012] The aforementioned air inlet cam shaft 2 has structure which opens and closes three inlet valves per cylinder, and the exhaust air cam shaft 3 has structure which opens and closes two exhaust valves per cylinder. The cam by which sign 2in drawing 1 a was formed in the air inlet cam shaft 2, and 3a are the cams formed in the exhaust air cam shaft 3. The moving valve mechanism of this engine 1 has well-known structure conventionally these cams 2a and 3a press an inlet valve and an exhaust valve through a lifter (not shown). Moreover, 7 shows the position of the combustion chamber of this engine 1, and 7a shows the position of an ignition plug.

[0013] The adjustable mechanism 8 in which the rotation position of cam 2a is changed to the rotation position of the pulley gear tooth 5 is formed in the axis end section of the aforementioned air inlet cam shaft 2. This adjustable mechanism 8 has the structure of changing continuously the rotation phase of the air inlet cam shaft 2 to the pulley gear tooth 5, and changing the opening-and-closing time of an inlet valve.

[0014] 9 is a control unit for controlling the aforementioned adjustable mechanism 8. The rotational frequency sensor 10 which detects the rotational frequency of an engine 1, and the air flow meter 11 which detects an inhalation air content are connected, and this control unit 9 is constituted so that it may determine based on map 9a which assigned the amount of angles of delay of the inlet valve in the adjustable mechanism 8 to the engine speed and the mean effective pressure.

[0015] The aforementioned map 9a is constituted as shown in drawing 3 , and it calculates the amount of angles of delay of inlet-valve valve-closing time as a crank angle from the knock frequency to an engine speed and a mean effective pressure. It asks for the mean effective pressure of the vertical axis of map 9a from the output of the aforementioned air flow meter 11. That is, the adjustable mechanism 8 is controlled so that the amount of angles of delay becomes large gradually as an engine speed becomes small, or as an inhalation air content increases. In addition, it is the angle-of-rotation sensor which is shown with the sign 12 in drawing 1 , and it is constituted so that passage of the salient 13 prepared in the aforementioned adjustable mechanism 8 may be detected electrically or magnetically.

[0016] In the four stroke cycle engine constituted as mentioned above, control of the adjustable mechanism 8 is not performed at the time of a low rotation low load, but combustion is performed by the high real compression ratio. The opening-and-closing time of the inlet valve at this time and an exhaust valve becomes as it was shown in drawing 2 (a). In drawing 2 , EX shows opening and closing of an exhaust valve, and IN shows opening and closing of an inlet valve. Moreover, TDC shows the time of a piston being located in a top dead center. The opening-and-closing time of the inlet valve and exhaust valve which were shown in drawing 2 (a) is set up so that the opening-and-closing time in the time of the high rotation heavy load of the conventional engine, abbreviation, etc. may be spread and may become. That is, it is, before closing an exhaust valve at the time of the end like an exhaust air line, and before a piston goes up to a top dead center, an inlet valve opens. Moreover, this inlet valve is closed, after a piston passes a bottom dead point and goes into a compression stroke.

[0017] and -- if throttle opening becomes larger than control start opening and an engine will be in a low rotation heavy load state, while an engine speed becomes smaller than a control start rotational frequency -- a control unit 9 -- electromagnetism -- a solenoid 20 is excited and angle-of-delay control of the opening-and-closing stage of an inlet valve is carried out This angle-of-delay control is performed by a control unit 9 reading the amount of angles of delay according to an engine speed and throttle opening from map 9a. For example, when the amount of angles of delay is 20 degrees, from drawing 2 (a), 20 degrees of the open stages and closed stages of an inlet valve shift clockwise, and they come to show in this drawing (b).

[0018] Namely, it becomes since a piston starts descent from a top dead center that an inlet valve opens, and as for closing, a piston becomes since a up stroke carries out abbreviation half elevation. At this time, the first stage of compression becomes late and a real compression ratio falls.

[0019] Moreover, it becomes as 20 more degrees shifts from the state of drawing 2 (b) and it is shown in this drawing (c), when the amount of angles of delay is 40 degrees. At this time, the first stage of compression is further overdue, and a real compression ratio falls further at it.
[0020] That is, even if it sets it as a high value from which knocking tends to produce the compression ratio of an engine 1, a compression ratio becomes small substantially. For this reason, at the time of the low rotation heavy load which knocking tends to generate, combustion is performed with the real compression ratio as abbreviation conventional, knocking will be suppressed, and when controlled by valve timing proper in addition to the time of a low rotation heavy load, combustion will be performed with a high real compression ratio.
[0021] Moreover, in this example, since the open time of an inlet valve is also overdue, a bulb roll decreases or it completely comes to be lost. That is, a charging efficiency falls also by this and it is hard coming to generate knocking.

[0022] Moreover, although the example which used the inhalation air content was shown in detecting the load of an engine 1 by this example, the throttle opening sensor which detects throttle opening instead of an air flow meter 11 can also be used.
[0023]
[Effect of the Invention] The four stroke cycle engine which starts this invention as explained above Since the adjustable mechanism in which the opening-and-closing time of an inlet valve was changed into a valve gear was established and the control unit which changes the valve-closing time of an inlet valve according to an engine speed and a load was connected to this adjustable mechanism, while setting the compression ratio as the high value with sufficient thermal efficiency, A substantial compression ratio becomes [that the time when the angle of delay of the valve-closing time of an inlet valve is sharply carried out at at the time of the service condition (low rotation heavy load) to which knocking tends to take place, and a compression stroke starts is overdue, and a charging efficiency] low small by the bird clapper. For this reason, at the time of a low rotation heavy load, combustion is performed with the real compression ratio as abbreviation conventional, knocking is suppressed and combustion is performed with the highest real compression ratio by controlling the valve-closing time of an inlet valve according to the grade of the knocking at the time of other service conditions.
[0024] Therefore, the optimal inhalation-of-air valve timing according to the grade of knocking can be chosen, combustion comes to be performed with the optimal higher real compression ratio, and mpg becomes low while high power is moreover obtained since there is also no need of delaying ignition timing, in order to suppress knocking.

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CLAIMS

[Claim(s)]
[Claim 1] The four stroke cycle engine which establishes the adjustable mechanism in which the opening-and-closing time of an inlet valve is changed into the valve gear which opens and closes the aforementioned inlet valve, and is characterized by connecting to this adjustable mechanism the control unit which changes the valve-closing time of an inlet valve according to the grade of knocking in the four stroke cycle engine by which an inlet valve and an exhaust valve are opened and closed by the separate valve gear while setting the compression ratio of this engine as a high value with sufficient thermal efficiency.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the plan expanding and showing the important section of the four stroke cycle engine concerning this invention.
[Drawing 2] In drawing showing the opening-and-closing timing of an inlet valve and an exhaust valve, this drawing (a) shows the state when not operating an adjustable mechanism, this drawing (b) shows the state when carrying out 20-degree angle of delay of the valve-closing stage of an inlet valve, and this drawing (c) shows the state when carrying out 40-degree angle of delay of the valve-closing stage of an inlet valve.
[Drawing 3] It is the map of the amount of inhalation-of-air valve timing angles of delay.
[Description of Notations]
2 Air Inlet Cam Shaft
8 Adjustable Mechanism
9 Control Unit
9a Map
10 Rotational Frequency Sensor
11 Air Flow Meter

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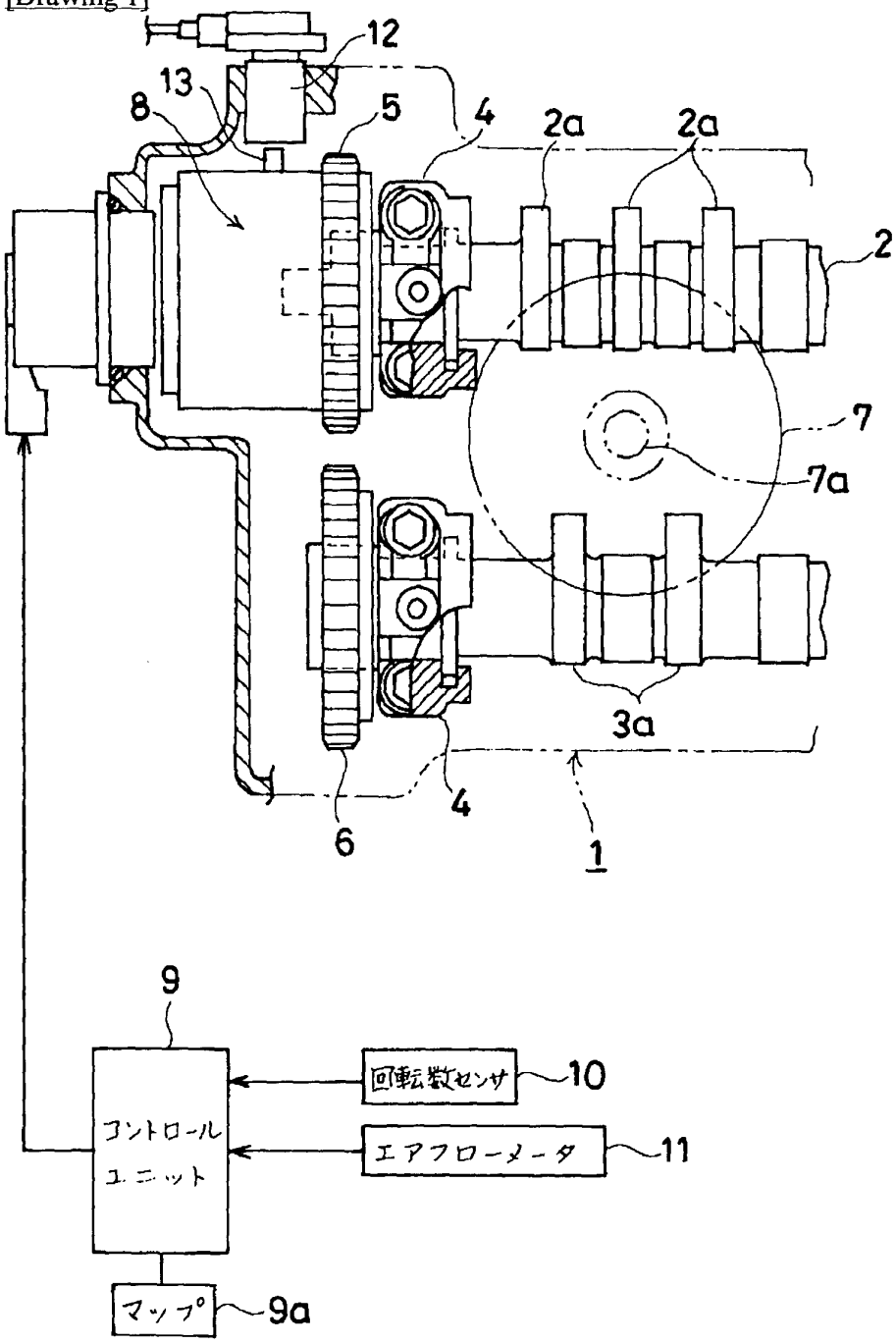
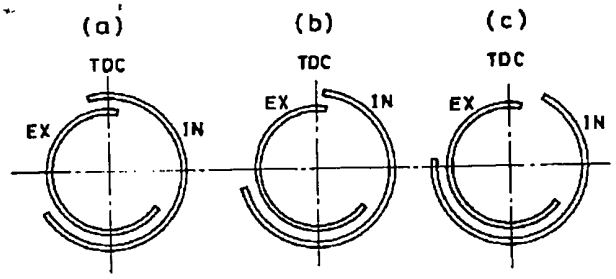
DRAWINGS

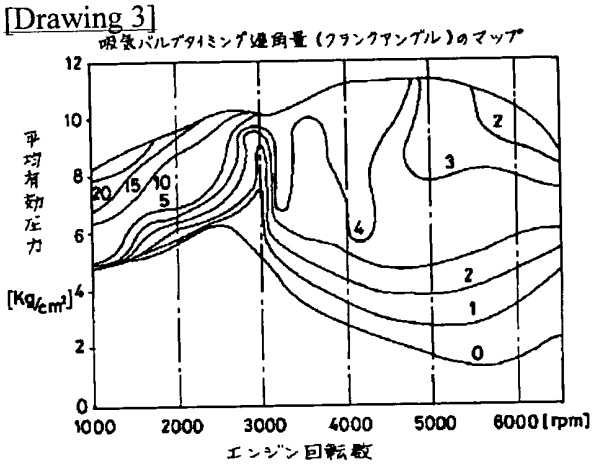
[Drawing 1]



[Drawing 2]



[Drawing 3]



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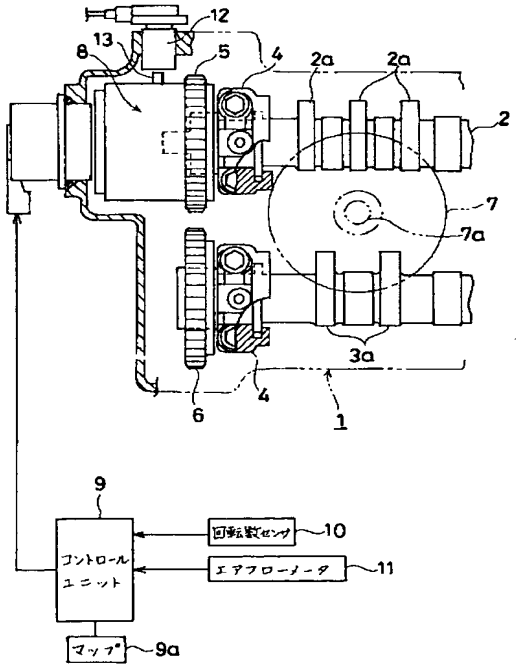
(54)【発明の名称】　４サイクルエンジン

(57)【要約】
【目的】　圧縮比を高く設定しつつノッキングが生じるのを抑えて高出力化，低燃費化を図る。
【構成】　圧縮比を熱効率のよい高い値に設定する。吸気カム軸２に吸気弁の開閉時期を変える可変機構８を設ける。この可変機構８に、低回転高負荷時に吸気弁の閉弁時期を変更するコントロールユニット９を接続した。低回転高負荷時には吸気弁の閉弁時期が変更されて圧縮始めの時期が遅くなり実圧縮比が低下する。このため、ノッキングを抑えつつ圧縮比を高く設定でき、高出力が得られると共に燃費が低くなる。



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【特許請求の範囲】

【請求項１】　吸気弁と排気弁が別々の動弁機構によって開閉される４サイクルエンジンにおいて、このエンジンの圧縮比を熱効率のよい高い値に設定すると共に、前記吸気弁を開閉する動弁機構に吸気弁の開閉時期を変える可変機構を設け、この可変機構に、ノッキングの程度に応じて吸気弁の閉弁時期を変更する制御装置を接続したことを特徴とする４サイクルエンジン。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、吸気弁が排気弁とは別個の動弁機構によって開閉される４サイクルエンジンに関し、特に低回転高負荷時に圧縮比を下げてノッキングが発生するのを抑える装置に関するものである。

【０００２】

【従来の技術】４サイクルエンジンで出力向上，燃費向上を図るには圧縮比を可及的高めることが望ましい。ところが、このようにするとノッキングが生じ易くなる関係から、高圧縮比化を図るにも限度がある。このノッキングは、エンジン負荷が小さいときにはシリンダ内に吸入される空気量が少なく有効圧力が小さい関係から圧縮比を大きくしても生じ難いが、高負荷時には吸気の充填効率が高くなるために圧縮比を大きく設定すると生じ易くなる。

【０００３】この高負荷時でも混合気が強い乱流により攪拌されるような高回転時より、シリンダ内でガス流動が比較的少なくなる低回転時の方がノッキングが生じ易い。

【０００４】従来の４サイクルエンジンは、低回転高負荷時にノッキングが発生しない程度の圧縮比に設定されていた。そして、ノッキングが発生したときにはノックセンサによってそれを検出し、ノッキングが生じ難くなるように点火時期を遅らせていた。

【０００５】

【発明が解決しようとする課題】しかるに、上述したように圧縮比を低回転高負荷時にノッキングが発生しない程度の小さい値に設定したのでは、エンジンの出力および燃費を向上させるにも限度があった。しかも、ノッキングが生じたときに点火時期を遅らせるとトルクが低下してしまう。

【０００６】本発明はこのような問題点を解消するためになされたもので、圧縮比を高く設定しつつノッキングが生じるのを抑え、高出力化および低燃費化を図ることを目的とする。

【０００７】

【課題を解決するための手段】本発明に係る４サイクルエンジンは、圧縮比を熱効率のよい高い値に設定すると共に、動弁機構に吸気弁の開閉時期を変える可変機構を設け、この可変機構に、ノッキングの程度に応じて吸気弁の閉弁時期を変更する制御装置を接続したものである。

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【０００８】

【作用】最もノッキングの起こり易い運転条件（低回転高負荷）時には吸気弁の閉弁時期を大幅に遅角して圧縮行程の始まる時期が遅れることと、充填効率が低くなることにより実質的な圧縮比が小さくなる。このため、低回転高負荷時には略従来通りの実圧縮比で燃焼が行われてノッキングが抑制され、その他の運転条件時にはそのノッキングの程度に応じて吸気弁の閉弁時期を制御することにより最も高い実圧縮比で燃焼が行われる。

【０００９】

【実施例】以下、本発明の一実施例を図１ないし図３によって詳細に説明する。図１は本発明に係る４サイクルエンジンの要部を拡大して示す平面図、図２は吸気弁と排気弁の開閉タイミングを示す図で、同図（ａ）は可変機構を作動させないときの状態を示し、同図（ｂ）は吸気弁の閉弁時期を２０°遅角させたときの状態を示し、同図（ｃ）は吸気弁の閉弁時期を４０°遅角させたときの状態を示す。図３は吸気バルブタイミング遅角量のマップである。

【００１０】これらの図において、１は本発明に係る４サイクルエンジンで、このエンジン１は吸気弁（図示せず）と排気弁（図示せず）とを別個のカム軸で開閉するいわゆる２頭上カム軸式エンジンである。また、このエンジン１の圧縮比は、従来のエンジンに対して比較的高い値に設定されている。詳述すると、低回転高負荷時にノッキングが発生し易くなる高い値に設定されている。具体的には、１１．５以上である。

【００１１】２は吸気弁を開閉する吸気カム軸、３は排気弁を開閉する排気カム軸で、これらのカム軸は軸受４によってシリンダヘッド１ａにそれぞれ回転自在に支持されており、軸端部に形成されたプーリ歯５，６が不図示のタイミングベルトを介してクランク軸（図示せず）に連結されている。

【００１２】前記吸気カム軸２は１気筒当たり３個の吸気弁を開閉する構造になっており、排気カム軸３は１気筒当たり２個の排気弁を開閉する構造になっている。図１中符号２ａは吸気カム軸２に形成されたカム、３ａは排気カム軸３に形成されたカムである。このエンジン１の動弁装置は、これらのカム２ａ，３ａがリフタ（図示せず）を介して吸気弁や排気弁を押圧する従来周知の構造になっている。また、７はこのエンジン１の燃焼室の位置を示し、７ａは点火プラグの位置を示す。

【００１３】前記吸気カム軸２の軸端部にはプーリ歯５の回転位置に対してカム２ａの回転位置を変える可変機構８が設けられている。この可変機構８は、プーリ歯５に対して吸気カム軸２の回転位相を連続的に変えて吸気弁の開閉時期を変える構造になっている。

【００１４】９は前記可変機構８を制御するためのコントロールユニットである。このコントロールユニット９

は、エンジン１の回転数を検出する回転数センサ１０と、吸入空気量を検出するエアフローメータ１１とが接続され、可変機構８での吸気弁の遅角量をエンジン回転数と平均有効圧力に割り付けたマップ９ａに基づいて決定するように構成されている。

【００１５】前記マップ９ａは図３に示したように構成され、エンジン回転数と平均有効圧力に対するノック頻度から吸気弁閉弁時期の遅角量をクランクアングルとして求めたものである。マップ９ａの縦軸の平均有効圧力は、前記エアフローメータ１１の出力から求める。すなわち、エンジン回転数が小さくなるにしたがって、あるいは、吸入空気量が多くなるにしたがって遅角量が次第に大きくなるように可変機構８が制御される。なお、図１中符号１２で示すものは回転角センサであり、前記可変機構８に設けられた突起１３の通過を電気的あるいは磁気的に検出するように構成されている。

【００１６】上述したように構成された４サイクルエンジンでは、低回転低負荷時には可変機構８の制御は行われず、高い実圧縮比で燃焼が行われる。このときの吸気弁および排気弁の開閉時期は図２（ａ）に示した通りとなる。図２においてＥＸは排気弁の開閉を示し、ＩＮは吸気弁の開閉を示す。また、ＴＤＣはピストンが上死点に位置するときを示す。図２（ａ）に示した吸気弁および排気弁の開閉時期は、従来のエンジンの高回転高負荷時での開閉時期と略等しくなるように設定されている。すなわち、排気行程の終了時に排気弁が閉まる以前であってピストンが上死点まで上昇する以前に吸気弁が開く。また、この吸気弁はピストンが下死点を過ぎて圧縮行程に入ってから閉まる。

【００１７】そして、エンジン回転数が制御開始回転数より小さくなると共に、スロットル開度が制御開始開度より大きくなってエンジンが低回転高負荷状態になると、コントロールユニット９が電磁ソレノイド２０を励磁させて吸気弁の開閉時期が遅角制御される。この遅角制御は、コントロールユニット９がエンジン回転数およびスロットル開度に応じた遅角量をマップ９ａから読み出して行われる。例えば、遅角量が２０°である場合には吸気弁の開時期および閉時期が図２（ａ）より時計回りに２０°ずれて同図（ｂ）に示すようになる。

【００１８】すなわち、吸気弁が開くのはピストンが上死点から下降を開始してからとなり、閉じるのはピストンが上昇行程の約半分上昇してからとなる。このときには、圧縮始めの時期が遅くなり実圧縮比が低下する。

【００１９】また、遅角量が４０°である場合には、図２（ｂ）の状態よりさらに２０°ずれて同図（ｃ）に示す通りとなる。このときには、圧縮始めの時期がさらに遅れ、実圧縮比がさらに低下する。

【００２０】すなわち、エンジン１の圧縮比をノッキングが生じ易いような高い値に設定しても、実質的に圧縮比が小さくなる。このため、最もノッキングが発生し易い低回転高負荷時には略従来通りの実圧縮比で燃焼が行われてノッキングが抑制され、低回転高負荷時以外には適正なバルブタイミングにコントロールされることにより高い実圧縮比で燃焼が行われることになる。

【００２１】また、本実施例では吸気弁の開時期も遅れるから、バルブオーバラップが少なくなるか、あるいは全く無くなるようになる。すなわち、これによっても充填効率が低下してノッキングが発生し難くなる。

【００２２】また、本実施例ではエンジン１の負荷を検出するに当たって吸入空気量を使用した例を示したが、エアフローメータ１１の代わりにスロットル開度を検出するスロットル開度センサを用いることもできる。

【００２３】

【発明の効果】以上説明したように本発明に係る４サイクルエンジンは、圧縮比を熱効率のよい高い値に設定すると共に、動弁機構に吸気弁の開閉時期を変える可変機構を設け、この可変機構に、エンジン回転数と負荷に応じて吸気弁の閉弁時期を変更する制御装置を接続したため、最もノッキングの起こり易い運転条件（低回転高負荷）時には吸気弁の閉弁時期を大幅に遅角して圧縮行程の始まる時期が遅れることと、充填効率が低くなることにより実質的な圧縮比が小さくなる。このため、低回転高負荷時には略従来通りの実圧縮比で燃焼が行われてノッキングが抑制され、その他の運転条件時にはそのノッキングの程度に応じて吸気弁の閉弁時期を制御することにより最も高い実圧縮比で燃焼が行われる。

【００２４】したがって、ノッキングの程度に応じた最適な吸気バルブタイミングを選ぶことができ、より高く最適な実圧縮比で燃焼が行われるようになり、しかも、ノッキングを抑制するために点火時期を遅らせる必要も無いから、高出力が得られると共に燃費が低くなる。

【図面の簡単な説明】

【図１】本発明に係る４サイクルエンジンの要部を拡大して示す平面図である。

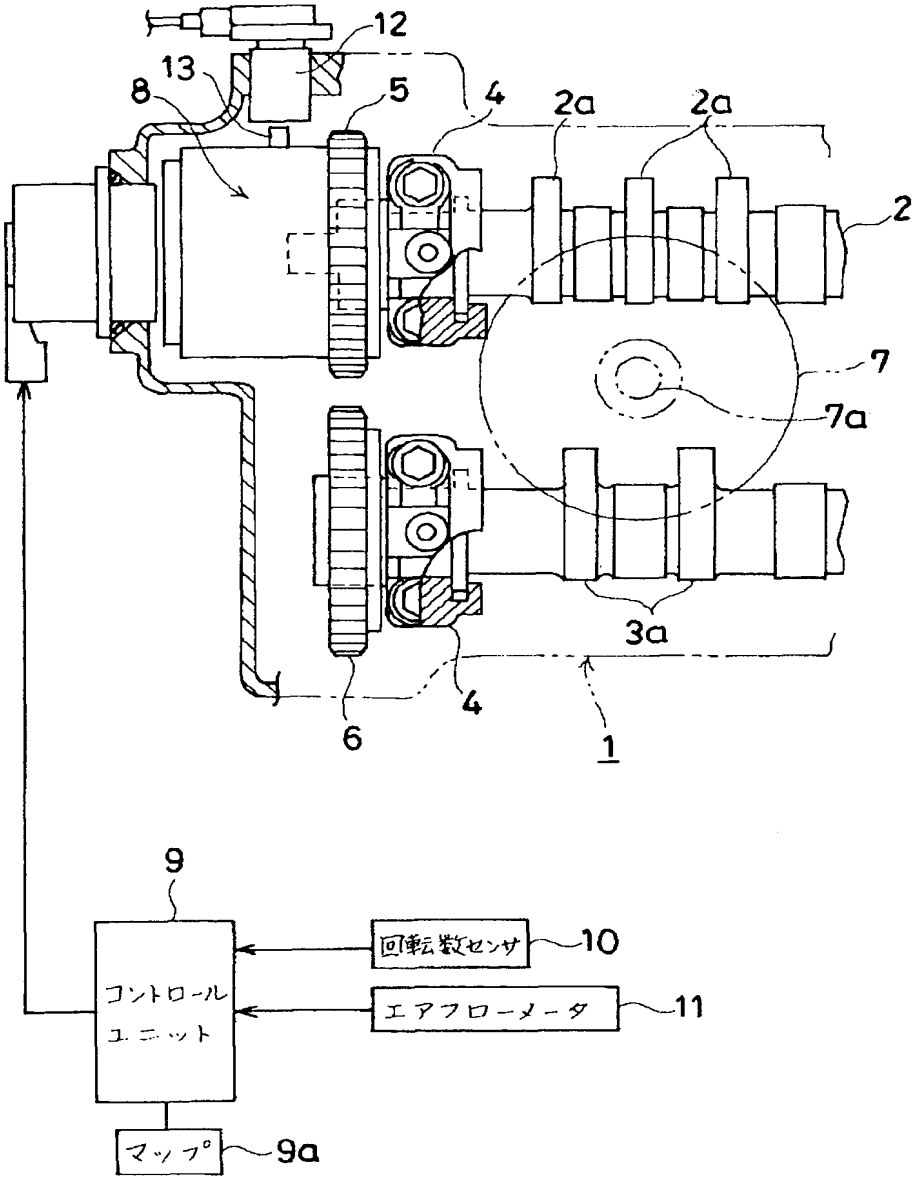
【図２】吸気弁と排気弁の開閉タイミングを示す図で、同図（ａ）は可変機構を作動させないときの状態を示し、同図（ｂ）は吸気弁の閉弁時期を２０°遅角させたときの状態を示し、同図（ｃ）は吸気弁の閉弁時期を４０°遅角させたときの状態を示す。

【図３】吸気バルブタイミング遅角量のマップである。

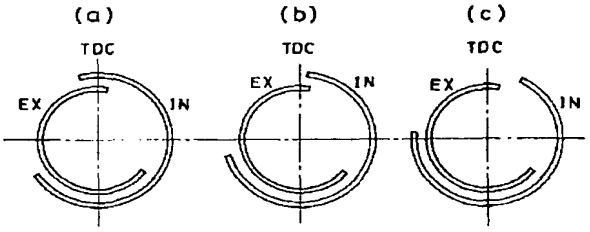
【符号の説明】

２　吸気カム軸
８　可変機構
９　コントロールユニット
９ａ　マップ
１０　回転数センサ
１１　エアフローメータ

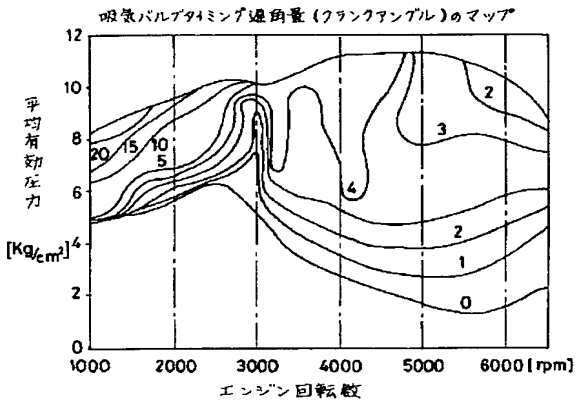
【図１】


12
13
8
5
4
2a
2a
2
7
7a
3a
4
6
1
9
コントロール
ユニット
回転数センサ
10
エアフローメータ
11
マップ
9a

【図２】


(a)
TDC
EX
IN
(b)
TDC
EX
IN
(c)
TDC
EX
IN

【図３】


吸気バルブタイミング遅角量（クランクアングル）のマップ
平均有効圧力
[Kg/cm²]
12
10
8
6
4
2
0
20
15
10
5
4
3
2
2
1
0
1000
2000
3000
4000
5000
6000[rpm]
エンジン回転数